'Kids save lives': why schoolchildren should train in cardiopulmonary resuscitation

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Abstract: PURPOSE OF REVIEW Quick initiation of basic life support (BLS) by laypersons is one of the most successful strategies in the fight against sudden cardiac death. In developed countries, cardiac arrest is still a major contributor to avoidable death, and despite the fact that more than 50% of all cardiac arrests are witnessed, layperson BLS is performed in less than 20%. To improve this situation, BLS training in schools has been established. RECENT FINDINGS Cardiopulmonary resuscitation (CPR) instruction including the use of automatic external defibrillators (AEDs) has shown to be feasible even for young schoolchildren, and there is an indication that respective programmes are effective to enhance patient outcome on a population basis. Earlier training may even lead to more sustainable results; however, it is reasonable to implement adjusted curricula for different child ages. The programme 'Kids Save Lives' recently endorsed by the WHO will help promoting school-based BLS training worldwide demanding education on CPR for all pupils starting at least at age 12. SUMMARY Resuscitation training in schools can help to increase the amount of BLS-trained population. Social skills of pupils can be improved and training can be successfully implemented independently of the pupils' age and physique.

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'Kids save lives': why schoolchildren should train in cardiopulmonary resuscitation

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Purpose of review
Quick initiation of basic life support (BLS) by laypersons is one of the most successful strategies in the fight against sudden cardiac death. In developed countries, cardiac arrest is still a major contributor to avoidable death, and despite the fact that more than 50% of all cardiac arrests are witnessed, layperson BLS is performed in less than 20%. To improve this situation, BLS training in schools has been established.

Recent findings
Cardiopulmonary resuscitation (CPR) instruction including the use of automatic external defibrillators (AEDs) has shown to be feasible even for young schoolchildren, and there is an indication that respective programmes are effective to enhance patient outcome on a population basis. Earlier training may even lead to more sustainable results; however, it is reasonable to implement adjusted curricula for different child ages. The programme 'Kids Save Lives' recently endorsed by the WHO will help promoting school-based BLS training worldwide demanding education on CPR for all pupils starting at least at age 12.

Summary
Resuscitation training in schools can help to increase the amount of BLS-trained population. Social skills of pupils can be improved and training can be successfully implemented independently of the pupils' age and physique.

Keywords
basic life support, first aid, lay resuscitation, schoolchildren, training

INTRODUCTION

Sudden cardiac arrest is a major cause of death outside the hospital in Europe. Cardiopulmonary resuscitation (CPR) by laypersons (so-called bystanders) improves the chances of survival by a factor of 2–4 [1–3]. But although this circumstance is widely recognized, actual bystander CPR rates have remained low over the past years in many European countries. Data from Germany report rates of around 20%, whilst the proportion of layperson witnessed arrests is 50% of all cases [4–6]. Comparable numbers are reported from other countries [7,8]. The need for improvement of this situation has led to a number of initiatives all over Europe including the proclamation of an annual 'European Cardiac Arrest Awareness Day' by the European Parliament.

Even in an ideal setting, emergency medical services (EMS) arrival times amount to at least several minutes; most of the time, however, it takes longer. In rural German EMS, it has been shown that only 62% of all cardiac arrest patients are reached within 8 min [6]. If these time intervals are related to hypoxia tolerance of brain tissue, it becomes clear why cardiac arrest survival is so much dependent on bystander CPR. There is broad consensus that layperson CPR rates urgently need to be increased in order to close the so-called 'bystander's window'. Accordingly, the European Resuscitation Council's (ERC) 2010 guidelines recommend EMS dispatchers to instruct callers to provide CPR. This strategy can increase the amount of layperson CPR especially in private home settings [3,9,10].

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KEY POINTS

- Basic life support (BLS) training in schools leads to measurable positive effects and may be introduced as a school subject, independent of children's age.
- BLS training is likely to be more sustainable if instruction is started early in the learning career and should have a modular structure, starting with essentials subsequently extending to more complex elements.
- To date, long-term studies (>5 years) on the retention of information and skills in BLS training are lacking.
- The few barriers that exist to resuscitation training in schools should not be allowed to prevent it from being introduced throughout Europe.
- A widely agreed curriculum for school-based BLS training is lacking.

It is difficult to reach large parts of the population if CPR training is not mandatory. Nevertheless, education of laypersons in BLS is the most effective way to improve knowledge and skills on cardiac arrest and CPR [9–11]. It is therefore a logical consequence to include BLS training into school education. In consequence, the American Heart Association (AHA) advocated obligatory resuscitation training for U.S. schools in 2011 [12].

Other countries have already successfully implemented BLS training into school education. Results are impressive, although a direct causal relation to increased layperson CPR rates reported from these countries is yet to be proven [13].

CARDIOPULMONARY RESUSCITATION TRAINING: WHY SCHOOLS?

Only in schools is it realistic to cover large parts of society with comprehensive CPR training. In addition, starting at early stages of lifelong learning offers a sustainable approach with many advantages. It enhances pupils' alertness in recognizing a cardiac arrest and their knowledge of BLS procedures. Trained students (as well as teachers) can be effective 'CPR-multipliers' both in private and public settings. Over years, society's contingent of trained BLS-providers would gradually increase leading to higher lay-BLS rates [14▪▪]. As it has been estimated that at least 15% of a population need to be trained to achieve significant gains in resuscitation outcome [15], it seems unrealistic that voluntary programmes alone will solve the problem.

Also, BLS training in schools reaches every stratum of society. It has been shown that access to health-related information is lower in disadvantaged social classes, resulting in a higher cardiac arrest rates in these populations [16]. Pupils' sense of responsibility and so-called social skills need to be established in a child's education and BLS training could effectively contribute to both. Altruism research has provided data suggesting that schoolchildren's approach to BLS training is less fearful than that of adolescents [17]. Knowing that the strongest obstacle of action in cardiac arrest is the fear of 'doing harm' [18,19], it seems a good option to ascertain children in their pragmatic approach to cardiac arrest [17].

From an educational perspective, school time offers a natural opportunity to acquire learning content step-by-step: this approach may establish the essentials of CPR at early times (recognition of cardiac arrest, communication with emergency medical dispatch, chest compressions) while adding more complex elements of CPR later (such as ventilation). Knowledge and skills may be built up in an ascending manner (from simple to complex, from important to less important) and may be consolidated in every new step, resulting in what educationalists call a 'spiral curriculum'.

Although first-aid courses attended by adults have to be given a meaningful context by the participants themselves, linking BLS training with other school topics is easily possible: CPR can be taught in subjects such as biology, physical education, health education or others.

REQUIREMENTS FOR SUCCESSFUL IMPLEMENTATION

Some examples of broad school training programs show that these are effective and are even successful on a level relevant to patient outcome. In the region of Stavanger, Norway, after a widespread school programme involving more than 54 000 schoolchildren by use of a DVD-based self-instruction kit, bystander BLS rate grew from 60 to 73%. This rise was accompanied by an improved hospital discharge rate arrest from 18 to 25% [20,21]. In Copenhagen, Denmark, 35 000 schoolchildren received training, also by means of a self-instruction kit. Bystander CPR rate rose from 25 to 27.9% [22]. Although this difference was not significant, the authors could show that using the self-instruction kit, the trained children themselves had taught in average 2.5 additional individuals in BLS.

If programmes are to be as successful as the cited ones, certain requirements have to be taken into account. Learning content needs to be adjusted to intellectual and physical capabilities. All studies published so far on this topic have shown positive learning effects independent of children's age.

However, most studies were conducted with adolescent pupils [23–25,26▪▪,27,28]. One paper though reported that children aged 4–5 years were able to learn to recognize cardiac arrest, initiate an emergency call and open an airway [29]. On the contrary, chest compression depth is significantly better for older pupils. This is most likely the result of greater body weight, or of physical strength [23,24,26▪▪]. Pupils' age and weight also have a significant influence on chest compression recoil and tidal volume during simulated resuscitation [23–25,30,31]. In a German longitudinal study with frequent school-based BLS training, it was shown that male pupils of higher age were able to reach deeper chest compressions. Nevertheless, within the study period (4 years), all participating students improved their results and performance was best in those pupils taking part in the study for the longest [24].

WHAT SHOULD BASIC LIFE SUPPORT TRAINING CONSIST OF?

As evidence-based recommendations for CPR are available (ERC Guidelines), training should be based on those, and not on first-aid-course curricula, which are often outdated [32▪]. Basic lessons should at least cover recognition of cardiac arrest (in particular the phenomenon of 'agonal breathing'), activation of EMS (emergency phone number) and interaction with the dispatcher (following instructions) and provision of sufficient chest compressions. Pupils in every age group can be taught a basic understanding of the circulatory system and its failure [33]. Students should be conveyed that many cardiac arrests are witnessed by family or close friends at home. The most plausible scenario in which schoolchildren could become eye-witnesses of a cardiac arrest is probably when visiting their grandparents. Even limited comprehension of the physiology of cardiac arrest is known to triple the likelihood of a layperson recognizing a cardiac arrest [4]. The recognition of collapse, unconsciousness and the detection of agonal breathing is not a trivial matter [34] and therefore needs to be taught carefully. The assessment of 'agonal breathing' and ventilatory arrest by the 'look, listen and feel' concept should be trained as well as opening the airway ('head tilt'). Training an emergency call should be kept simple. Historically, reporting schemes tended to be too complicated to reproduce. EMS dispatchers need to be capable to communicate with schoolchildren [35]; therefore, pupils should be taught above all the correct EMS phone number and to understand that support and help can be expected from the dispatcher. During simple telephone simulation exercises, children should learn how to activate an ambulance in case of an emergency. The highest priority of practical training should be put on chest compression. Schoolchildren should practice correct hand position and high-quality chest compressions (depth, frequency and recoil) [36].

Rescue breathing may be of value during ongoing resuscitation. However, several studies have shown that resuscitation by laypersons can be carried out successfully without rescue breathing [37,38]. Higher survival rates were only achieved if the ambulance needed more than 5 min to respond [39]. It needs to be respected that increasing the complexity of the resuscitation process can result in a dangerous shift in priorities [40] due to irritation of the rescuers. The instruction in rescue breathing should thus only be given during subsequent training lessons.

Recovery position has been a core element of first aid for decades. When it comes to cardiac arrest though, moving the patient in this position is known to jeopardize the success of resuscitation training. Frequently, former participants of first aid courses mistake 'agonal breathing' as a vital sign and leave the victim in the 'recovery position' while in cardiac arrest [41].

Use of an automated external defibrillator (AED) may be taught successfully and safely from the age of 6 [33,42–44]. Even without any training, nearly 50% of 12 to 14-year-old students knew what an AED was and what it is used for [44]. Schoolchildren aged 6–7 years are able to use the AED and make an emergency call during BLS correctly after training. This seems only logical when watching children easily using smartphones or tablet computers [33]. An AED can therefore be integrated in resuscitation teaching in schools, but it is still unclear from what age the use of an AED by children can be recommended.

HOW SHOULD TRAINING BE ORGANIZED?

Training can be organized in various ways and by different methods.

Theoretical training

Theoretical training is easy to organize, but in one study, it could be shown that results did not differ significantly from an untrained control group [45]. It has clearly been demonstrated that a combination of theory and practice is necessary for better outcomes [46].

Self-instruction

Self-instruction kits including a practice manikin and an instructional DVD or booklet are available

commercially. Norwegian studies [20,47] and a comparative trial from Denmark [22] have shown successful training effects by using these kits. In all cited studies, students regularly used the self-instruction kit to teach other individuals in BLS. Studies were able to show that lay-resuscitation rates and survival after cardiac arrest (hospital discharge) increased.

Computer-based learning

Studies with computer-based learning programmes also showed positive results [48,49]. Although computer-based training programmes are not capable of replacing practical training, they represent a type of CPR training that may be more suitable among teenagers than conventional courses. Computer-based learning might be an additional way of making the topic attractive and maintaining CPR awareness among schoolchildren [14▪▪].

Background of facilitators

In different studies conducted with professional teachers, emergency personnel, medical students or doctors, no advantage was shown for any specific professional group [14▪▪,24]. It is known that teachers, after completing an adequate training in BLS themselves, can be motivated to teach BLS to their pupils [50,51▪].

Teachers as facilitators offer various advantages: they have the educational skills needed and act as role models for their pupils. With teachers, training can be organized more easily and might be less expensive. With just one single training, teachers were able to train their students in BLS independently with the same effectiveness as medical staff or doctors [24]. School subjects such as biology and physical education may be most suitable to offer opportunities for BLS training at school.

Medical students are not only able to conduct BLS training after prior training, but they also benefit from their trainer status: medical students who had acted as BLS trainers showed better resuscitation skills than conventional medical students [52,53].

It is comprehensible that both doctors and emergency service staff can be used as BLS trainers [24]. First and foremost, doctors and emergency staff are needed as trainers for the trainers. In addition, doctors with an experience in emergency medicine can provide medical consultancy for BLS projects in schools.

HOW OFTEN IS TRAINING NEEDED?

Although a single BLS training results in short-term effects, studies have demonstrated a significant decline in skill retention if training is not repeated regularly [14▪▪,30,54]. Practical CPR skills are known to be maintained for a few months, yet one study demonstrated a return to before-training levels after 2 years [14▪▪]. This disappointing effect can be attributed to the inevitable lack of practical application of BLS skills. A generic exercise is not available for BLS skills, especially in laypersons, as a cardiac arrest is a relatively rare event and relatively young people have few contacts with people at risk. With the exception of a few specialists, this applies even to medical staff.

One longitudinal prospective study examined training frequencies [24]. Students who were retrained after 6 months showed no superior results than those who received annual training. The authors concluded that 'one repeat training event per year appeared to be effective and sufficient' [24].

STRATEGIES FOR IMPLEMENTATION

In 1999, the Department of Health and Human Services of the USA presented a model framework for BLS teaching in schools, followed by an 'Advisory Statement' on the topic by the AHA published in 2011 [12,55].

Despite numerous school-based BLS projects throughout Europe, there is a lack of comprehensive and consistent implementation strategies. Current and past projects range from single campaigns to national programmes and often the quality of the instruction remains unknown.

Curriculum

BLS training for schoolchildren needs an age-adjusted curriculum with a modular structure. Basic trainings need to be limited to a few skills that will be of immediate benefit for cardiac arrest victims. BLS training has to consist of large portions of practical skill training [44,45] and should start as early as possible (primary school). The whole entire schooling period should be used for repetitive instruction respecting pupils' different developmental stages [12,24].

Instruction of all children (repeated several times) during their schooling is an enormous task. Teachers have undoubtedly the greatest potential to complete this task in a sustainable manner [24,52]. BLS programmes in schools should ideally be adopted by regional medical professionals serving as mentors for their schools.

Facilities

Schools can use self-instruction kits for training, although these are not stable enough to be used

for multiple trainings and are not disinfectable after training of rescue breathing. Frequent training of groups of pupils leads to a wear-out of manikins. Therefore, a maintenance routine needs to be established prior to the start of a BLS programme. Disinfection costs and efforts need to be considered when training includes mouth-to-mouth respiration. If training covers the use AEDs, simulation devices have to be purchased.

An auxiliary web-based training platform (ideally applied and maintained by the ERC or national councils) could effectively support the training and assure that up-to-date content is provided. Web-based training can also lead to reduced costs and link regional and national educational bodies and aid organizations.

Finance

BLS training in schools will always require resources (material, trainers, preparation and so on). School teachers as BLS instructors can reduce the costs and efforts arising from the provision of professional healthcare providers for the lessons. 'Peer-teaching' by trained pupils also seems reasonable, yet there is a lack of data so far for this concept. With self-instruction kits, both working time of the facilitators and teaching can be reduced, but the kits are relatively costly. A 'multiplication effect' of this form of training can burst its effectiveness [56▪▪].

Although costs and effort appear to be manageable, political authorization at the level of educational policy is ultimately needed for the introduction of resuscitation teaching in schools.

CONCLUSION

Bystanders need to be activated to prevent one of the most frequent preventable causes of death in Europe: sudden cardiac arrest. Despite the fact that laypersons witness more than 50% of all cardiac arrests, only a small proportion initiates basic life-support measures. Making BLS training a school subject can effectively increase the amount of BLS-trained population. The social skills of the children can be impressively improved by BLS training and these lessons can be successfully implemented independently of the pupils' age and physique. The training will be more effective if started early and should therefore be carried out from primary level to school-leaving age. At kindergarten level (age 4), young children can learn to recognize a victim of sudden cardiac arrest and how to call the emergency dispatch. Later in their schooldays, pupils perform chest compressions during the next training. Further steps of the curriculum can take them to the use of an AED and rescue breathing. Data show that annual repetition of training (theory and practice) provided by trained teachers can lead to sufficient results.

Understanding how a worldwide consensus on resuscitation and concluding guidelines can exist without an international curriculum also being available for teaching of CPR for schoolchildren is not easy. Future CPR guidelines should therefore be supplemented by a statement on how schoolchildren can effectively train in BLS. It is an important task for the international resuscitation community to formulate a consensus on a training programme of CPR for schoolchildren. The financial issues need clarification, as there exists an evident public health benefit. This should no longer stand in the way of preventing up to 100 000 cases of sudden cardiac death per year in Europe.

Very recent developments

In January, the WHO endorsed the 'Kids Save Lives – Training school children in Cardiopulmonary Resuscitation Worldwide' statement issued by the European Patient Safety Foundation (EuPSF), the ERC, the International Liaison Committee on Resuscitation (ILCOR) and the World Federation of Societies of Anesthesiologists (WSFA). The statement aims at promoting school-based BLS training globally in order to improve survival. The joint statement demands education on CPR for all pupils starting at least at age 12. Hopefully, this statement will accelerate the implementation of obligatory BLS training worldwide.

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Conflicts of interest

There are no conflicts of interest.

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In this study you will learn that teaching schoolchildren can reach out into society.